


Power System Engineering, Inc.

Using Storage to Achieve Higher Renewable Penetration

ICC Energy Storage Program Workshops

Forward-Thinking Professionals
Helping Clients and Colleagues **ACHIEVE** Their **Goals.**

www.powersystem.org

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Areas of Discussion

- Introductory Thoughts
- Central Challenge to Resource Transformation
- Electricity Realities
- Three Analysis Examples
- Summary Points

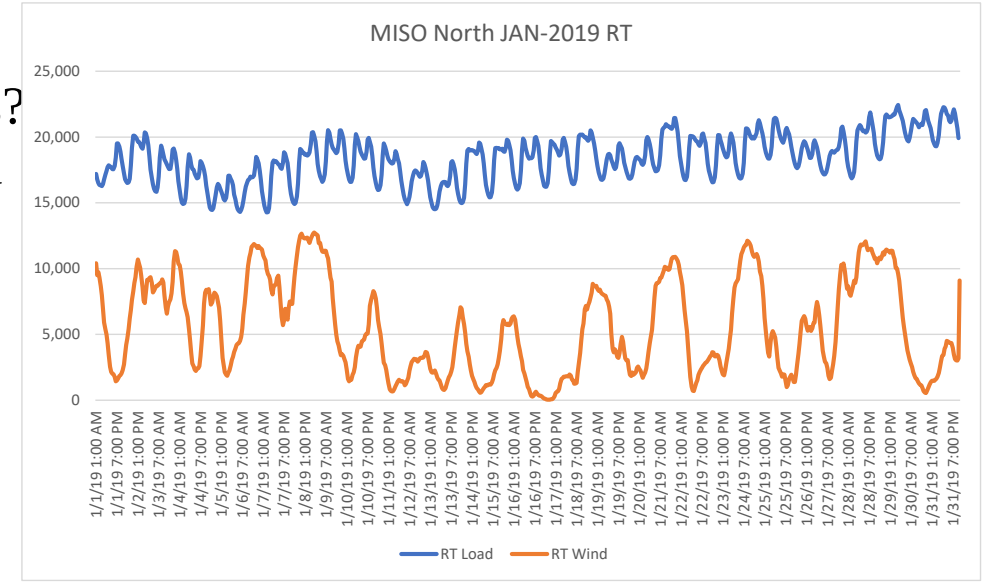
Power System Engineering – Portage WI Energy Storage

Other Power System Engineering Related Efforts

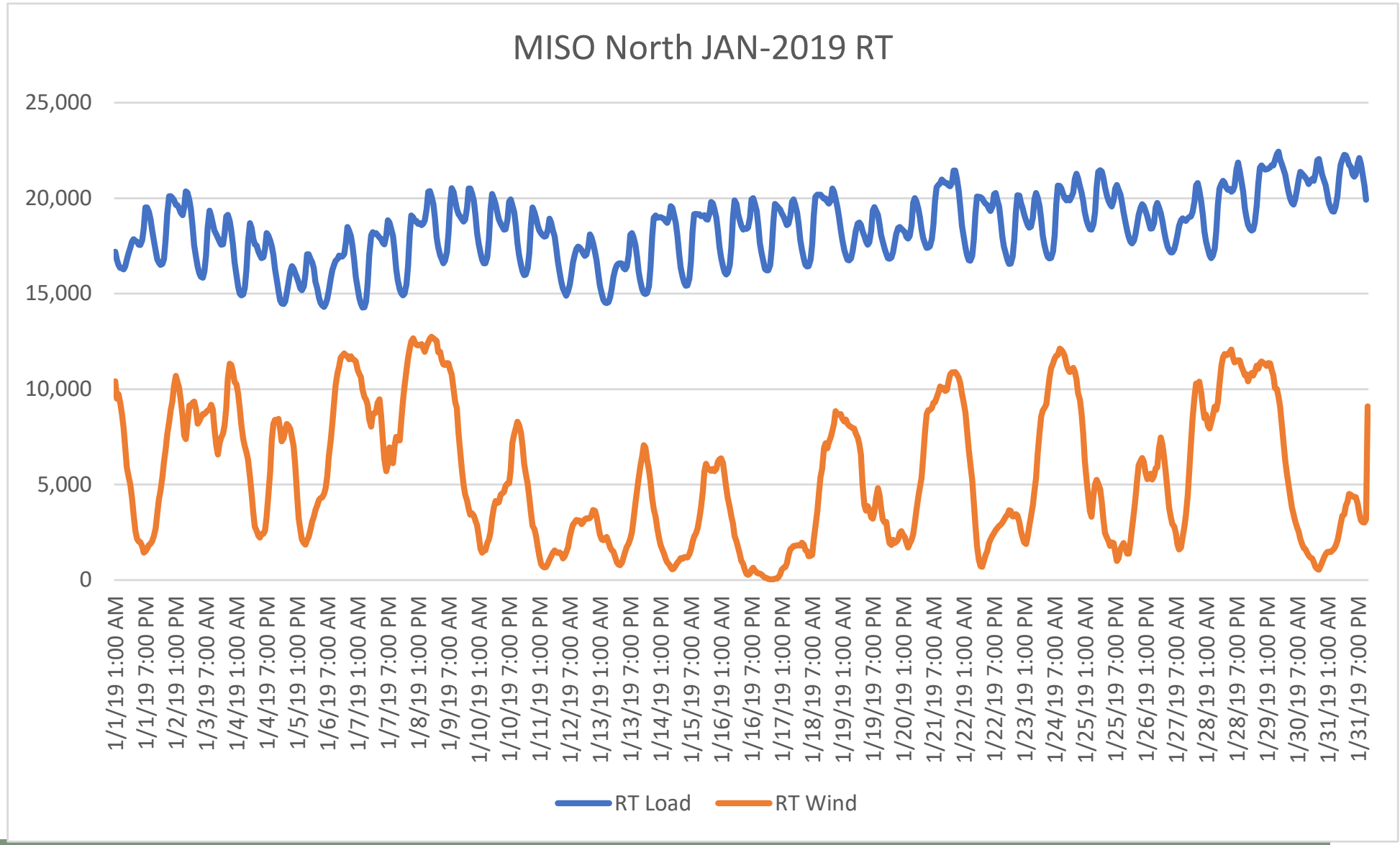
- Integrated Resource Plans
  - Power Production Modeling
  - Renewable Resource Evaluations
- Purchased Power Evaluations
- System Reliability
- MISO Level Modeling Discussions
  - Renewable Integration Impact Assessment
- Involved with MISO Resource Adequacy Subcommittee Discussions on Recently Filed Resource Adequacy Proposal
- Crystalized Years of Discussions to One Central Question…..

One Central Question ….

- Distinguish…
  - Annual Renewable Portfolio Objective
    - Annual Renewable MWh / Annual Load MWh
    - Simple Annual Ratio - Impacts of Shorter-Term Balances not Considered
  - Actual System Dispatch – Every Moment of the Year
    - Real-Time Delivery Challenges
    - Planning Reserve Sharing Impacts?
    - January 2019 MISO North Hourly



January 2019 – MISO North



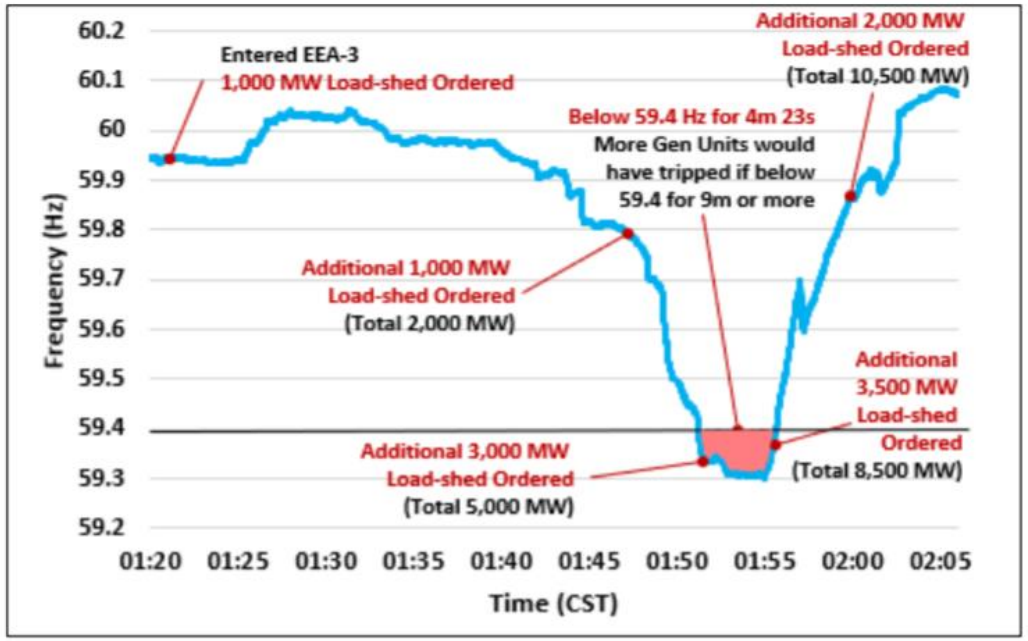
Electricity Delivery Realities

- Electricity - Real-Time Production, Transmission, and Usage
  - Unique to Any Other Energy System
- Reflected by Area Control Error (ACE) and System Frequency
- Monitored by Underfrequency Relaying
- Requires Adequate Planning – Adequate Lead Time for Real Time Operations

February 2021 Load Curtailment

Generation Decreases and Outages Led To Energy Emergencies in ERCOT, SPP and MISO BAs

- Each BA declared Energy Emergencies and ordered firm load shed, in total exceeding **23,400 MW**:
  - ERCOT: nearly three consecutive days of firm load shed and at worst point, **20,000 MW**,
  - SPP: approximately five hours total of firm load shed and at worst point, **2,700 MW**, and
  - MISO (MISO South): over two hours of firm load shed and at worst point, **700 MW**.



System frequency, an indicator of grid "health", dropped rapidly in ERCOT on February 15, due to a rapid decrease in generation. ERCOT operators made the correct decision to shed firm load to recover frequency to maintain reliability of the ERCOT grid and prevent further outages from occurring.

Renewable - Real-Time Dispatch Realities

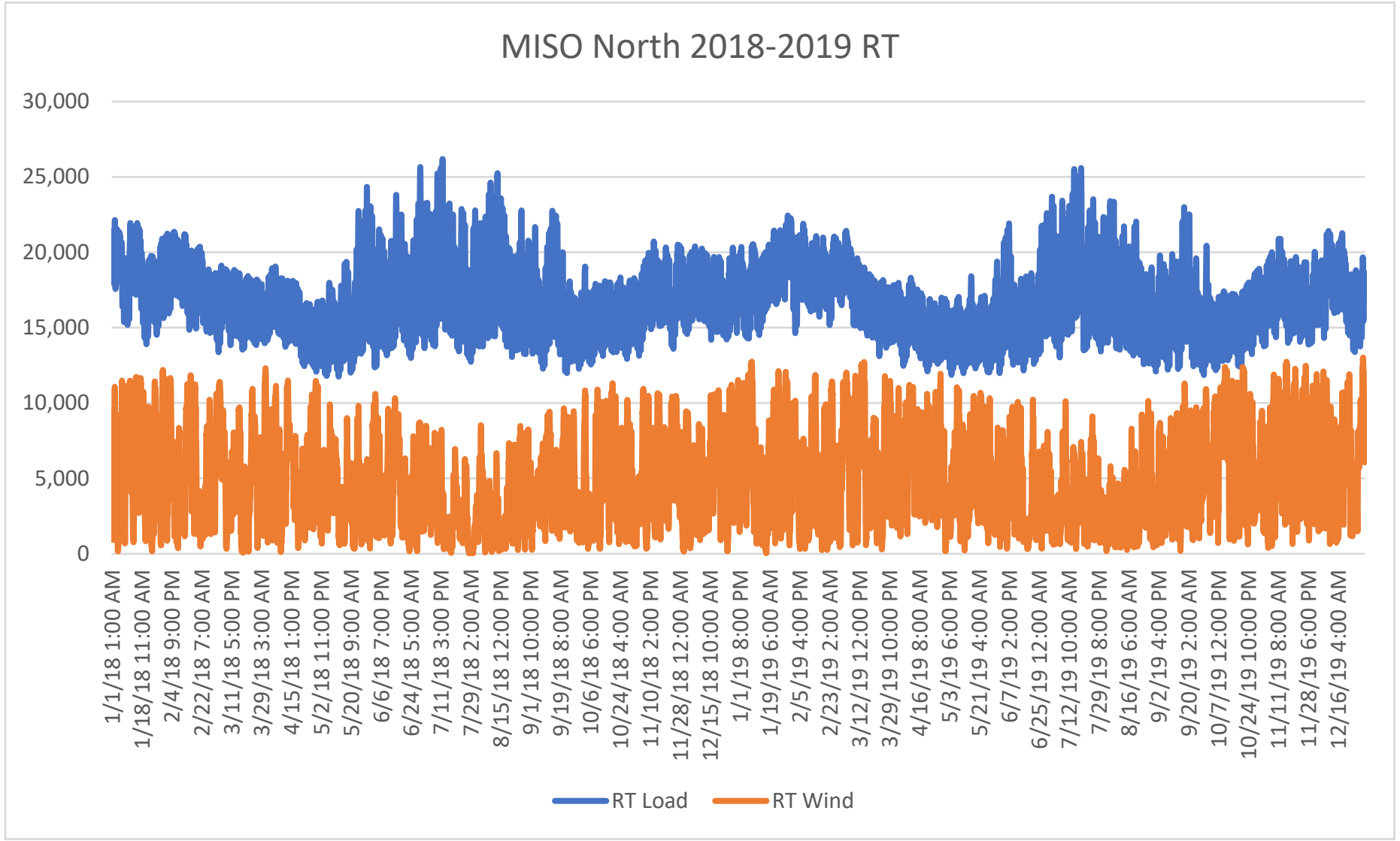
- Lower-Level Implementation
  - Alter Dispatch of Other Generation
- Higher-level Renewable Implementation
  - Surplus Dispatch
    - Meet Energy Needs of Other Entities
    - Export to Other Areas
    - Curtail Generation
    - Store Energy In Storage
  - Deficit Dispatch
    - Import from Other Area
    - Rely on Other Generation
    - Discharge Energy Storage

First Analysis Setup – Entity @ 100% Renewable(10% of MISO)

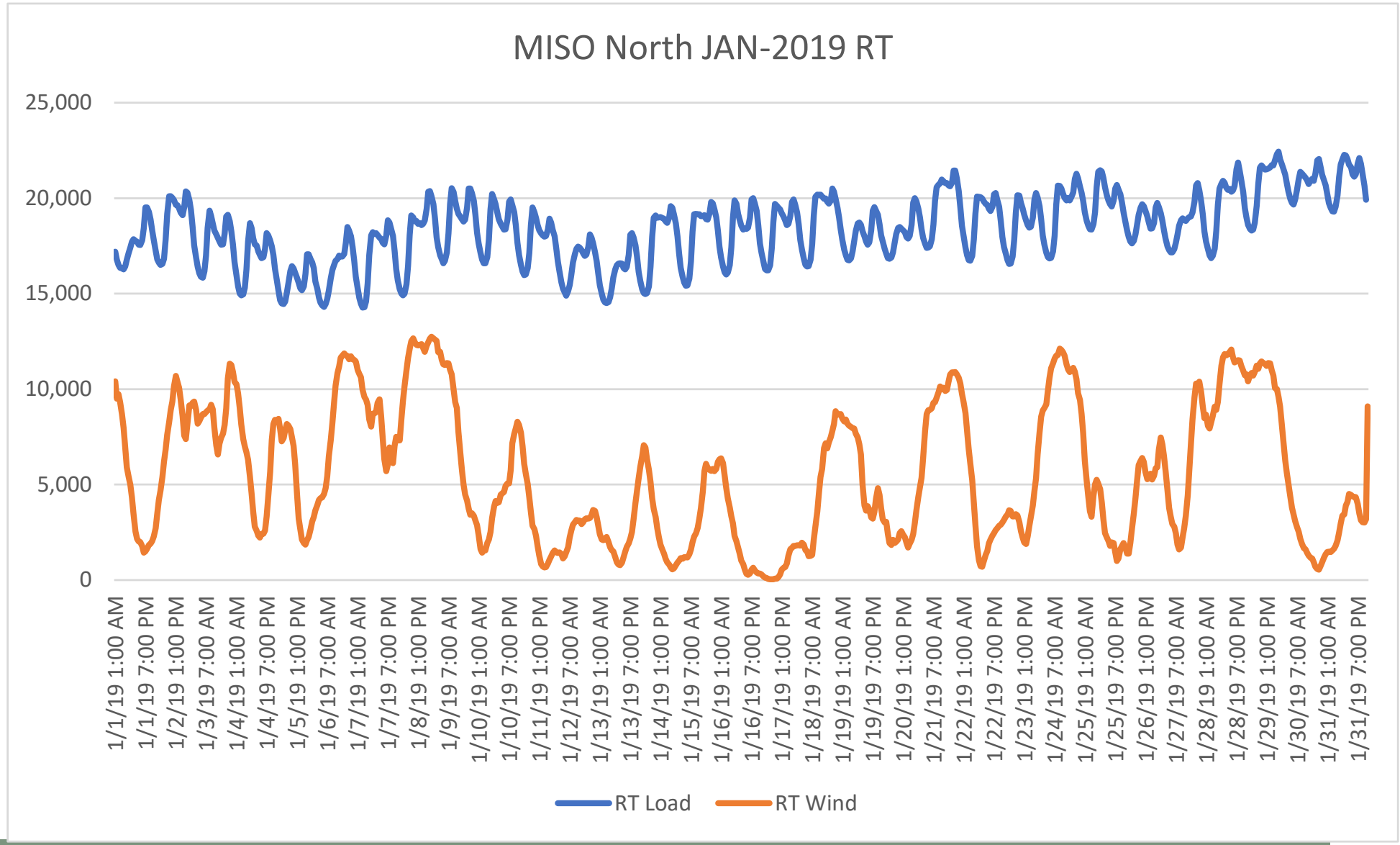
- Use 2018-2019 MISO North Hourly Data
  - Load and Wind Hourly MW
  - 26,188 MW Peak Load
  - Nearly 300,000 GWh Load
  - 86,061 GWh of Wind Generation – 28.82% Annual Percent of Load

- Simulated Entity Load => 10% MISO North
  - Simulate Individual Utility within MISO
  - Scale “Simulated” Entity to 77% Renewable
  - Show Entity Loadshape and Wind Shape
  - Show Impacts on MISO North

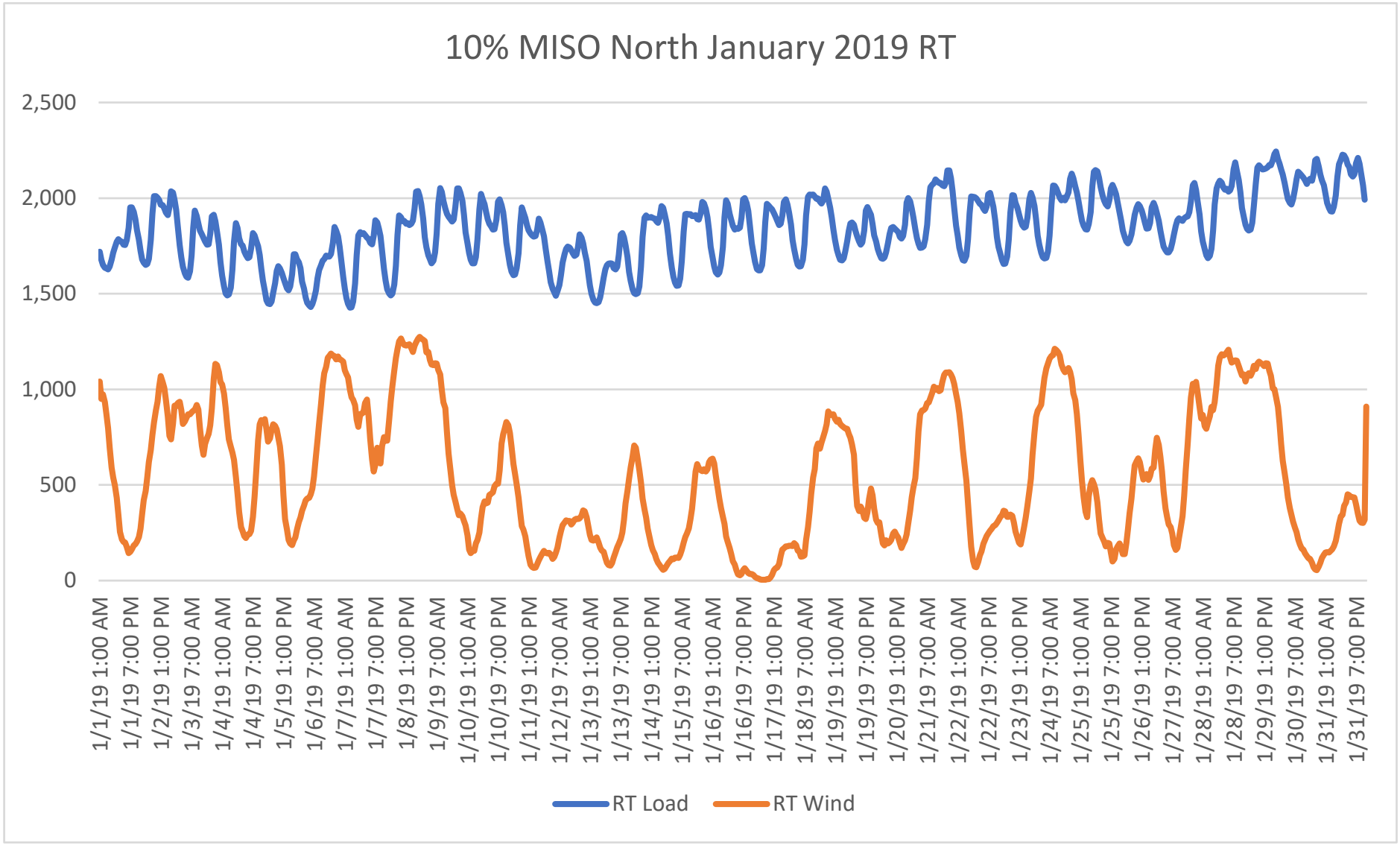
MISO North – 2018-2019 Hourly Load and Wind MW



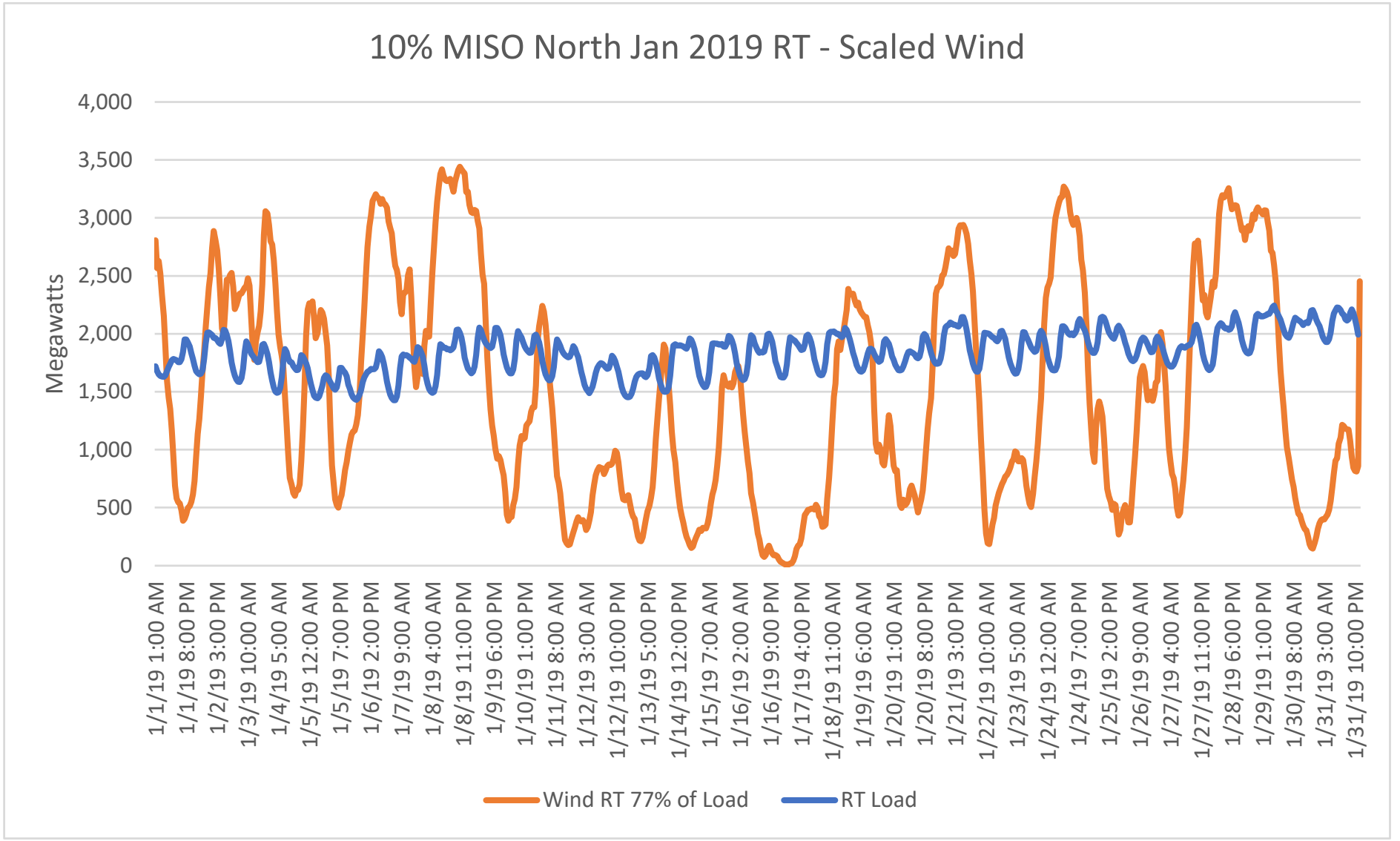
January 2019 – MISO North



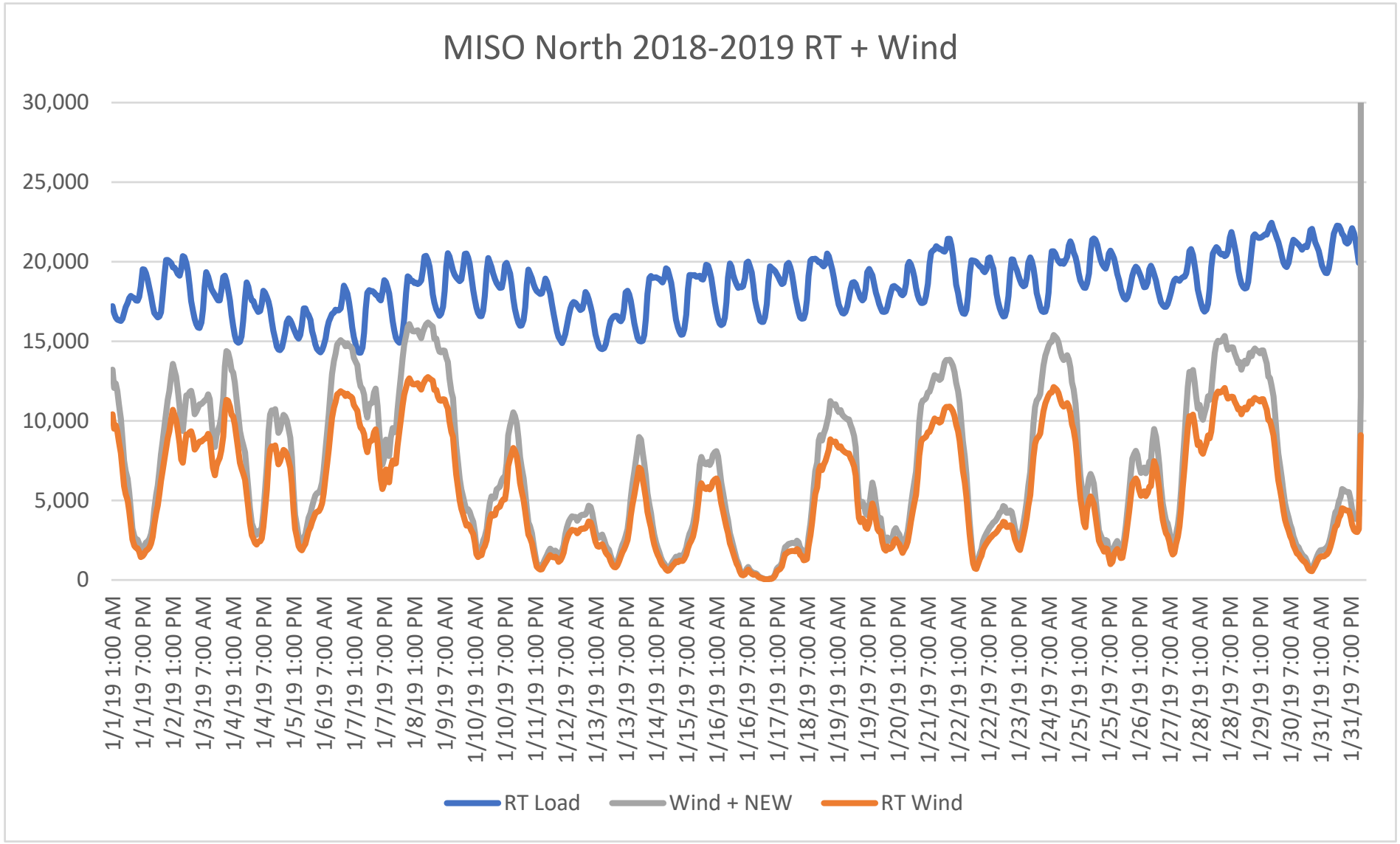
January 2019 – Simulated Entity 10% of MISO North



January 2019 – Simulated Entity – 77% Renewable



Jan 2019 – Impact of Additional Wind on MISO North

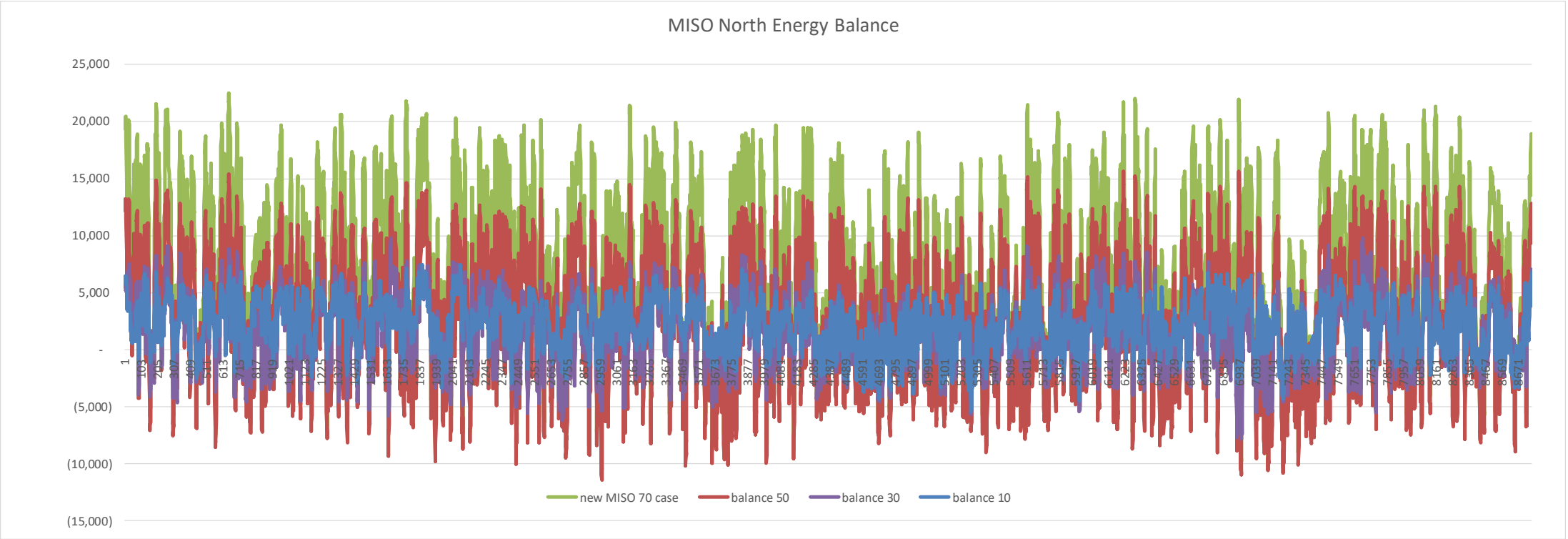


10% of MISO North Load – 100% Renewable - Summary

- Manageable Level of Dispatch Change
- Long/Short Positions Impact Balance of Resources
  - Impact of High Renewable Energy Implementation

Second Analysis - MISO North – Export/Import MW hourly

- 8760 Hour Chart – MISO RIIA Study (MISO % - MISO North %)
  - Blue 10% - 33%
  - Purple 30% - 56%
  - Red 50% - 79%

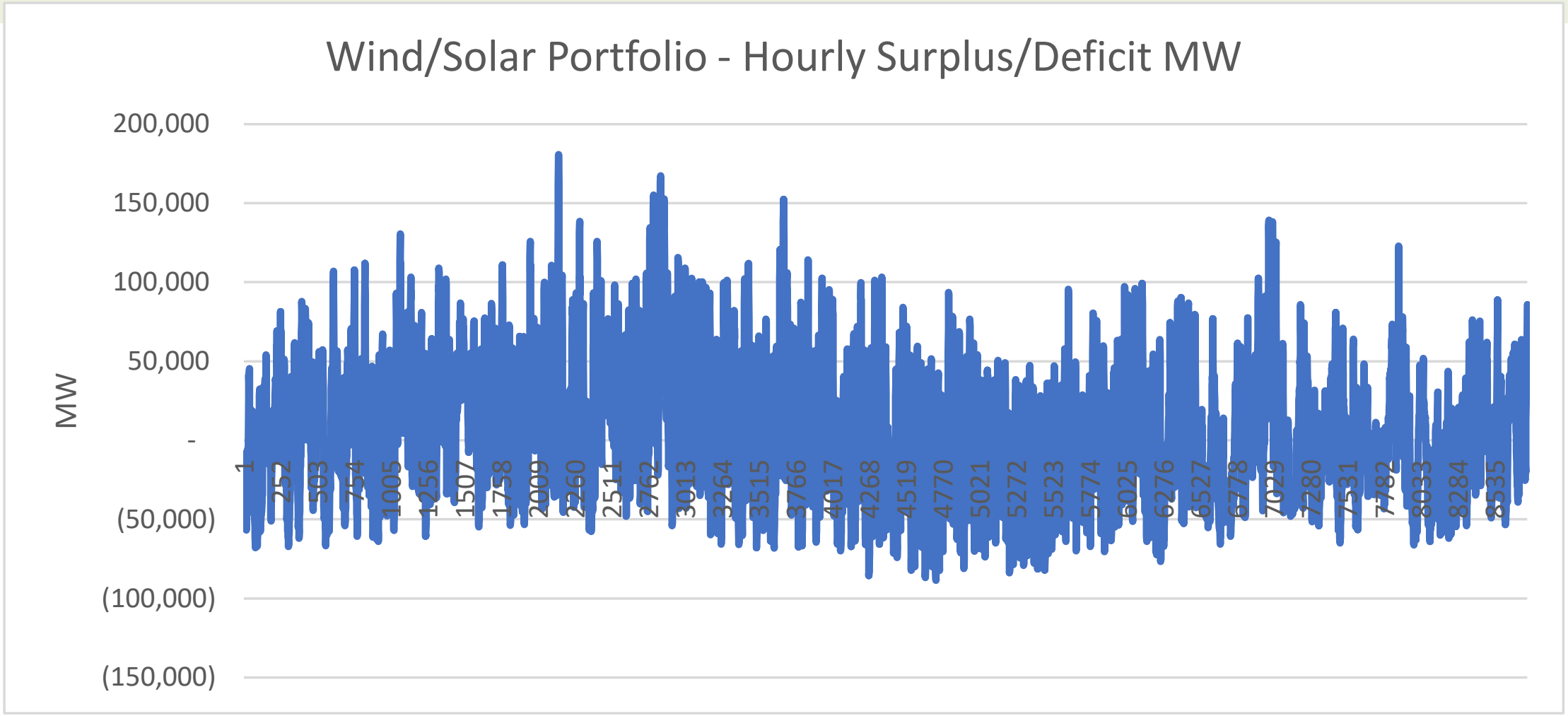


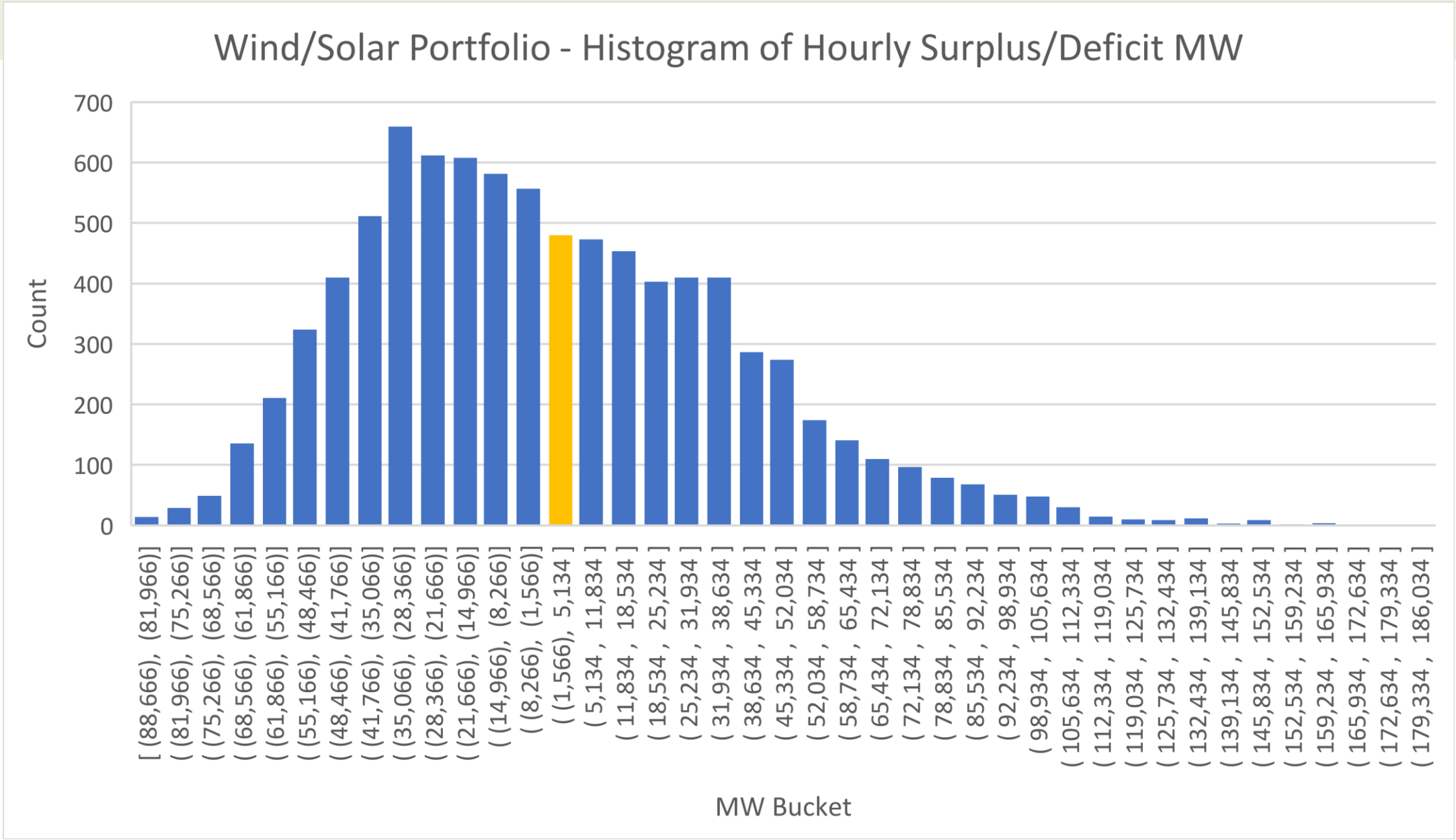
MISO North – Higher Renewable Generation - Summary Points

- 10, 20, 30, 40, 50 % Cases – Full MISO RIIA Simulated Dispatch
- Showing MISO North Balance of Resources
- MISO North – Local Renewable Percentages Higher Than MISO-wide Percentages Provides Leading Indicator of Renewable Impacts
- Notable Increases in Import/Export Levels for Higher Levels of Renewable Generation

Third Analysis - 100% Wind/Solar Target - Resource Portfolio Evaluation

- Load – Based on MISO 2018 RT Data
  - 101, 178 MW
  - 525,028 GWh (59.25%)
- Wind and Solar – Match Load MWh - Optimized for Minimizing Daily Mismatched Energy
- Wind - Scaled Wind to 6.6 times Historic
  - 102,467 MW
  - 332,104 GWh
- Solar - Scaled 5360 times Historic
  - 141,731 MW
  - 192,924 GWh



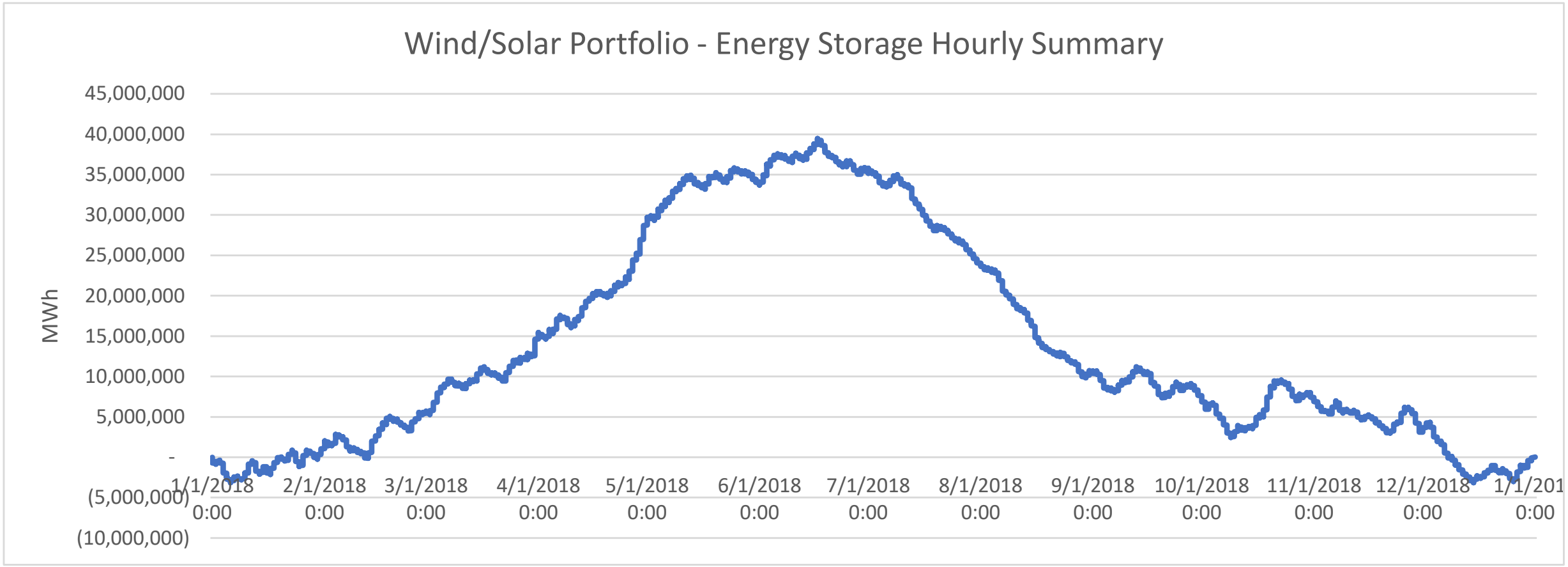


Imbalance Summary

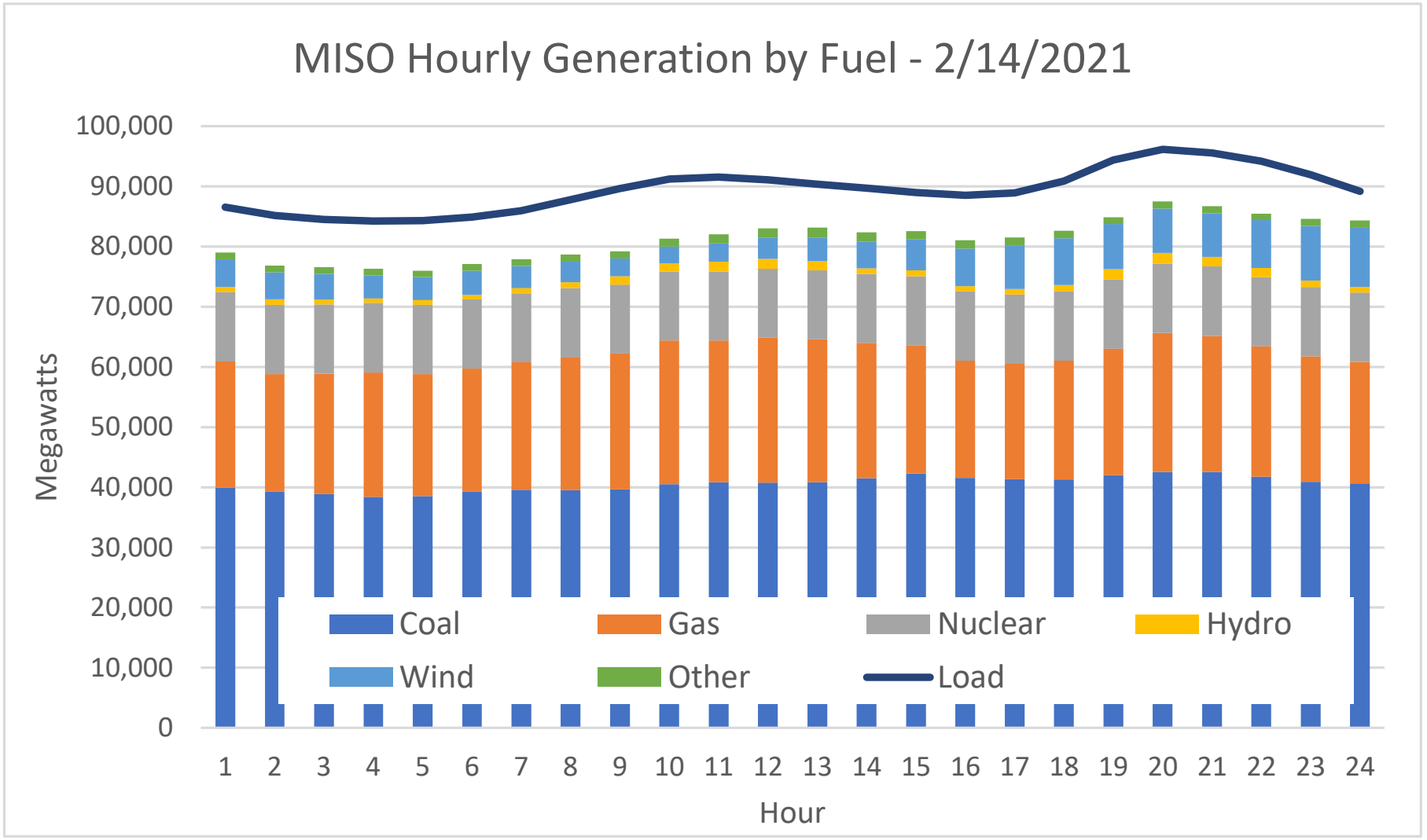
- Deficit
  - Energy – 139,794 GWh (27% of Annual Energy)
  - Highest MW Need – 88,666 MW (18% Capacity Factor)
  - Options
    - Import, Self-generate, Discharge Storage System
- Surplus
  - Energy – 139, 794 GWh (27% of Annual Energy)
  - Highest MW Surplus – 180,647 MW
  - Options
    - Export, Curtail Gen, Charge Storage System

Storage Option

- Simplified Approach
  - Zero Charge/Discharge Losses
  - Zero Discharge Over Time
- Model Wide Open Size –
  - Demonstrate Storage Profile
- Storage Pattern Occurs Over Longer Periods Than Typical 4, 8, 16 hour Designs



Snapshot of Feb 2021 Dispatch



Summary Points

- Regulators
  - What is the Means of Evaluating Electric System Reliability When Considering Resource Transformation?
    - Viewing Balance of Network Beyond Immediate System
- Generation Owners
  - Define Replacement Resources – before Baseload Retirements
    - How Many Hours of Energy Adequacy Needed Annually?
  - Describe Additional Nuclear Usage
- MISO/PJM
  - Digging Deeper - Provide Analysis Showing Dispatch Impacts
    - Resource Type Assessments?
    - Include Nuclear and Carbon Capture and Clearly Show How Much Storage is Needed

Carry Forward Thoughts

- Resource Portfolio Impacts on System Import/Exports
  - LSE Level
  - Regional Level
  - RTO Level
  - Eastern Interconnect Level
- Focus on Identified Dispatch Long/Short Positions
  - Driven by Renewable Dispatch Capabilities
  - Driven by Weather Related Load and Competing Fuel Evaluation
- Assess Storage Need Fully

Questions - Comments

Thank You

We look forward to helping you achieve your goals.

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